COSEWIC
Assessment and Status Report

on the

Eastern Wood-pewee
Contopus virens

in Canada

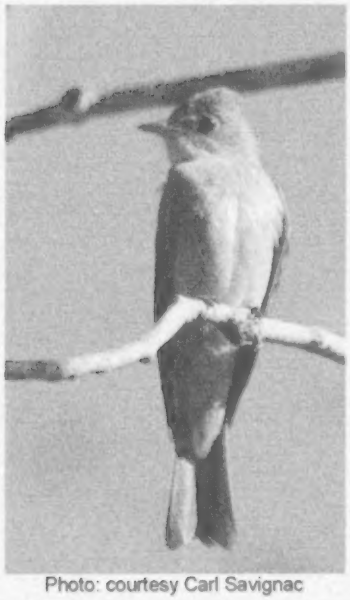

Photo: courtesy Carl Savignac

SPECIAL CONCERN
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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COSEWIC would like to acknowledge Carl Savignac for writing the status report on the Eastern Wood-pewee, *Contopus virens*, in Canada, prepared under contract with Environment Canada. The report was overseen and edited by Jon McCracken, COSEWIC Birds Specialist Subcommittee Co-chair.

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Eastern Wood-pewee — Photo: courtesy Carl Savignac.

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COSEWIC
Assessment Summary

Assessment Summary – November 2012

Common name
Eastern Wood-pewee

Scientific name
Contopus virens

Status
Special Concern

Reason for designation
This species is one of the most common and widespread songbirds associated with North America's eastern forests. While the species is apparently resilient to many kinds of habitat changes, like most other long-distance migrants that specialize on a diet of flying insects, it has experienced persistent declines over the past 40 years both in Canada and the United States. The 10-year rate of decline (25%) comes close to satisfying the criteria for Threatened. The causes of the decline are not understood, but might be linked to habitat loss or degradation on its wintering grounds in South America or changes in availability of insect prey. If the population declines continue to persist, the species may become Threatened in the foreseeable future.

Occurrence
Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia

Status history
Designated Special Concern in November 2012.

COSEWIC
Executive Summary

Eastern Wood-pewee
Contopus virens

Wildlife Species Description and Significance

The Eastern Wood-pewee is a small forest bird about the same size as a House Sparrow. Both sexes have similar plumage, being generally greyish-olive on the upperparts and pale on the underparts. This species is often observed perched in an upright position typical of flycatchers. It is distinguished from its 'confusing' *Empidonax* flycatcher cousins by its larger size, lack of an eye-ring, and longer and more pointed wings. During the breeding season, the most reliable way to detect and identify the Eastern Wood-pewee is by hearing its distinctive, clear, three-phrased whistled song, often paraphrased as "*pee-ah-wee.*"

Distribution

The breeding range of the Eastern Wood-pewee covers much of south-central and eastern North America. It breeds from southeastern Saskatchewan to the Maritime provinces, south to southeastern Texas and east to the U.S. Atlantic coast. About 11% of its global breeding range is in Canada, which accounts for about 8% of the breeding population.

It winters primarily in northern South America, mainly from northwestern Colombia and northeastern Venezuela south to southern Peru, northern Bolivia and Amazonian Brazil.

Habitat

In Canada, the Eastern Wood-pewee is mostly associated with the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in forest stands of intermediate age and in mature stands with little understory vegetation.

During migration, a variety of habitats are used, including forest edges, early successional clearings, and primary and secondary lowland (and submontane) tropical forest, as well as cloud forest. In South America in the winter, the species primarily uses open forest, shrubby habitats, and edges of primary forest. It also occurs in interior forests where tree-fall gaps are present.

Biology

The Eastern Wood-pewee is considered monogamous, but polygyny sometimes occurs. In Canada, adults arrive on the breeding grounds mostly from mid-May to the end of May. Pair formation and nest building start soon after arrival. Nests are usually located on top of a horizontal limb in a living tree at heights between 2 and 21 m. Clutch size averages 3 eggs. Incubation lasts about 12 to 13 days, and nestlings fledge after about 16 to 18 days. Up to two broods can be produced per year. Generation time is estimated to be 2-3 years.

Population Sizes and Trends

In Canada, the current Eastern Wood-pewee population is estimated to be about 217,500 breeding pairs or 435,000 mature individuals. Breeding Bird Survey (BBS) data for Canada indicate a significant population decline of 2.9% per year for the period 1970-2011, which yields an overall decline of 70% over the last 42 years. In the most recent 10-year period (2001 to 2011), BBS data show a significant decline of about 2.8% per year, which represents a 25% decline over the period. Populations declined significantly in Manitoba, Ontario, Québec, New Brunswick, and Nova Scotia/Prince Edward Island for the period of 1970-2011, with pronounced declines in Québec and New Brunswick. A pattern of widespread decline is also apparent for much of the United States.

The BBS trend generally conforms to the direction of results from two other monitoring programs (Study of Québec Bird Populations and Ontario Forest Bird Monitoring Program), but contrasts with those from other monitoring programs in Ontario (Ontario Breeding Bird Atlas and Long Point Bird Observatory migration monitoring), which suggest stable or increasing populations. Despite discrepancies across monitoring programs, the BBS is judged to represent the most reliable trend estimate at this time.

Threats and Limiting Factors

Threats and limiting factors affecting Eastern Wood-pewees have not been clearly identified and are poorly known, largely because of a lack of research. Possible threats and limiting factors have been suggested as including: 1) loss and degradation of habitat quality on the breeding grounds due to urban development and/or changes in forest management; 2) loss and/or degradation of habitat on the wintering grounds; 3) large-scale changes in the availability of flying-insect prey due to unknown causes; 4) high rates of mortality during migration and/or on the wintering grounds); 5) high rates of nest predation from increasing numbers of avian predators; and 6) changes in forest structure due to White-tailed Deer over-browsing.

Protection, Status, and Ranks

The Eastern Wood-pewee was ranked as 'globally secure' (G5) in 1996 by NatureServe and is considered 'Least concern' according to the IUCN Red List. In Canada, its nests and eggs are protected under the *Migratory Birds Convention Act*. Similar protection is afforded under various kinds of provincial legislation. It is considered 'secure and common' nationally; 'apparently secure' in Saskatchewan, Manitoba, Ontario, and Prince Edward Island; 'secure' in New Brunswick; and 'vulnerable' to 'apparently secure' in Québec.

TECHNICAL SUMMARY

Contopus virens
Eastern Wood-pewee Pioui de l'Est
Range of Occurrence in Canada: Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia, Prince Edward Island

Demographic Information

Generation time	2 to 3 yrs
Is there an observed, continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] - Trend estimates for short time frames (2 generations) do not provide robust information	Not estimated
Estimated percent reduction in total number of mature individuals over the last 10 years, or 3 generations. - Based on BBS data for 2001-2011 showing a significant decline of 2.81.% per year (95% CI: -3.65, -1.93).	25%
[Projected or suspected] percent reduction in total number of mature individuals over the next 10 years, or 3 generations.	Not estimated, but long-term decline is expected to continue
[Observed, estimated, inferred, or suspected] percent reduction in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Not estimated, but long-term patterns indicate a log-linear decline
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence - Based on a minimum convex polygon of the species' range map from NatureServe 2012, version 3, provided by Alain Filion	2,090,000 km^2
Index of area of occupancy (IAO) - IAO based upon the 2x2 km grid cell method cannot be calculated at this time because precise locations of nesting individuals have not been mapped. However, the estimated IAO would be far greater than COSEWIC's minimum threshold of 2000 km^2	Unknown but >2000 km^2
Is the total population severely fragmented?	No
Number of "locations"	Unknown; definitely >10
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy?	Unknown (yes in Maritimes, but apparently not elsewhere)
Is there an observed continuing decline in number of populations?	No
Is there an observed continuing decline in number of locations?	Unknown
Is there an observed, inferred or projected continuing decline in area and/or quality of habitat? - Habitat supply (forest cover) trends vary in different regions of Canada and are unknown on the wintering range; trend in habitat quality is unknown.	Unknown
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No

Are there extreme fluctuations in index of area of occupancy?	No

Number of mature individuals in each population

Population	N Mature Individuals
Total (217,500 breeding pairs)	435,000

Quantitative Analysis

Ex.: % chance of extinction in 50 years	Not done

Threats (actual or imminent, to populations or habitats)

Threats are not understood, but are thought to include:
1) degradation of habitat quality on the breeding grounds due to urban development and reduced levels of forest management;
2) loss and/or degradation of habitat on the wintering grounds;
3) large-scale changes in the availability of flying-insect prey due to unknown causes;
4) high rates of mortality during migration and/or on the wintering grounds;
5) high rates of nest predation from increasing numbers of avian predators; and
6) changes in forest structure due to White-tailed Deer over-browsing.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: statistically significant decline of 1.2% per year (1966-2010); significant declines are present for many northeastern states bordering Canada	
Is immigration known or possible?	Yes (highly likely)
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Possibly; tempered by current species decline in north-eastern US, especially in states bordering Canada

Current Status

COSEWIC: not assessed previously

Recommended Status and Reasons for Designation

Recommended Status:	**Alpha-numeric code:**
Special Concern	not applicable

Reasons for designation:

This species is one of the most common and widespread songbirds associated with North America's eastern forests. While the species is apparently resilient to many kinds of habitat changes, like most other long-distance migrants that specialize on a diet of flying insects, it has experienced persistent declines over the past 40 years both in Canada and the United States. The 10-year rate of decline (25%) comes close to satisfying the criteria for Threatened. The causes of the decline are not understood, but might be linked to habitat loss or degradation on its wintering grounds in South America or changes in availability of insect prey. If the population declines continue to persist, the species may become Threatened in the foreseeable future.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Does not meet criterion; the recent 10-year decline (25%) does not meet the 30% threshold for Threatened A2b.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criterion; exceeds thresholds for extent of occurrence and area of occupancy.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable; exceeds thresholds for population size
Criterion D (Very Small or Restricted Total Population): Not applicable; exceeds thresholds for population size, area of occupancy and number of locations.
Criterion E (Quantitative Analysis): Not done

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Eastern Wood-pewee

Contopus virens

in Canada

2012

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Contopus virens (Linnaeus, 1766) is commonly called the Eastern Wood-pewee. The French name is '*Pioui de l'Est*'. The taxonomy is as follows:

Class:	Aves
Order:	Passeriformes
Family:	Tyrannidae
Genus:	*Contopus*
Species:	*Contopus virens*

Morphological description

The Eastern Wood-pewee is a small forest bird (15 cm, 14 g; McCarty 1996). Both sexes have similar plumage. Adults have pale wing-bars, and are greyish-olive above and pale below, with a slightly darker greenish-wash on the breast and sides. This species is often observed in an upright position typical of flycatchers, and 'hawks' flying insects from perches (McCarty 1996).

In the field, the Eastern Wood-pewee is virtually indistinguishable in appearance from the Western Wood-pewee (*C. sordidulus*), which has a darker and browner chest and sides and has no tinge of green on the chest (McCarty 1996). Apart from notable differences in their breeding ranges, the Eastern Wood-pewee is best distinguished from its western counterpart by its clear, three-phrased song, often paraphrased as a whistled "*pee-ah-wee*". It is generally distinguished from similar-looking *Empidonax* flycatchers by its larger size, lack of an eye-ring, and longer and more pointed wings. The Eastern Wood-pewee also resembles the Eastern Phoebe (*Sayornis phoebe*), but is slightly smaller, has distinctive wing-bars, has a pale lower mandible, and lacks the phoebe's tail-wagging behaviour (McCarty 1996).

Population Genetic Structure and Variability

No research has been conducted on the population genetic structure of the Eastern Wood-pewee in Canada or the United States (McCarty 1996).

Designatable Units

No subspecies have been recognized or are currently known for the Eastern Wood-pewee (McCarty 1996; American Ornithologists' Union 1998) and there are no other distinctions that warrant assessment below the species level. This report deals with a single designable unit.

Special Significance

No particular aspect of the Eastern Wood-pewee's ecology appears to give it particular significance. No published Aboriginal traditional knowledge is currently available for this species in Canada.

DISTRIBUTION

Global Range

From west to east, the breeding range of the Eastern Wood-pewee extends from southeastern Saskatchewan, through southern Manitoba, Ontario and Québec, to the Canadian Maritimes. From the Canadian border with the U.S., it breeds south to southern Texas and east to the Atlantic coast (McCarty 1996; Figure 1).

Eastern Wood-pewees winter primarily in northern South America, from northwestern Colombia and northeastern Venezuela, south to southern Peru, northern Bolivia and Amazonian Brazil (McCarty 1996; Figure 1).

Canadian Range

About 11% of the Eastern Wood-pewee's global breeding range is in Canada, which accounts for about 8% of the global breeding population (Blancher *et al.* 2007; Table 1). It breeds in south-central and southeastern Canada, from New Brunswick, Prince Edward Island and Nova Scotia (BSC 2012), west through southern Québec north to Haute Cote-Nord, Gaspé peninsula and Îles-de-la-Madeleine (Cyr and Larivée 1995; Gauthier and Aubry 1995), though it has apparently not been recently recorded on Îles-de-la-Madeleine (Gauthier pers. comm. 2012). It occurs across most of southern Ontario north to Slate Falls to the west and Moose River to the east (Cadman *et al.* 2007). In the prairies, it breeds in southern Manitoba north to Duck Mountain Provincial Park (BSC 2011b), and southeastern Saskatchewan (Government of Saskatchewan 2011; Figure 2).

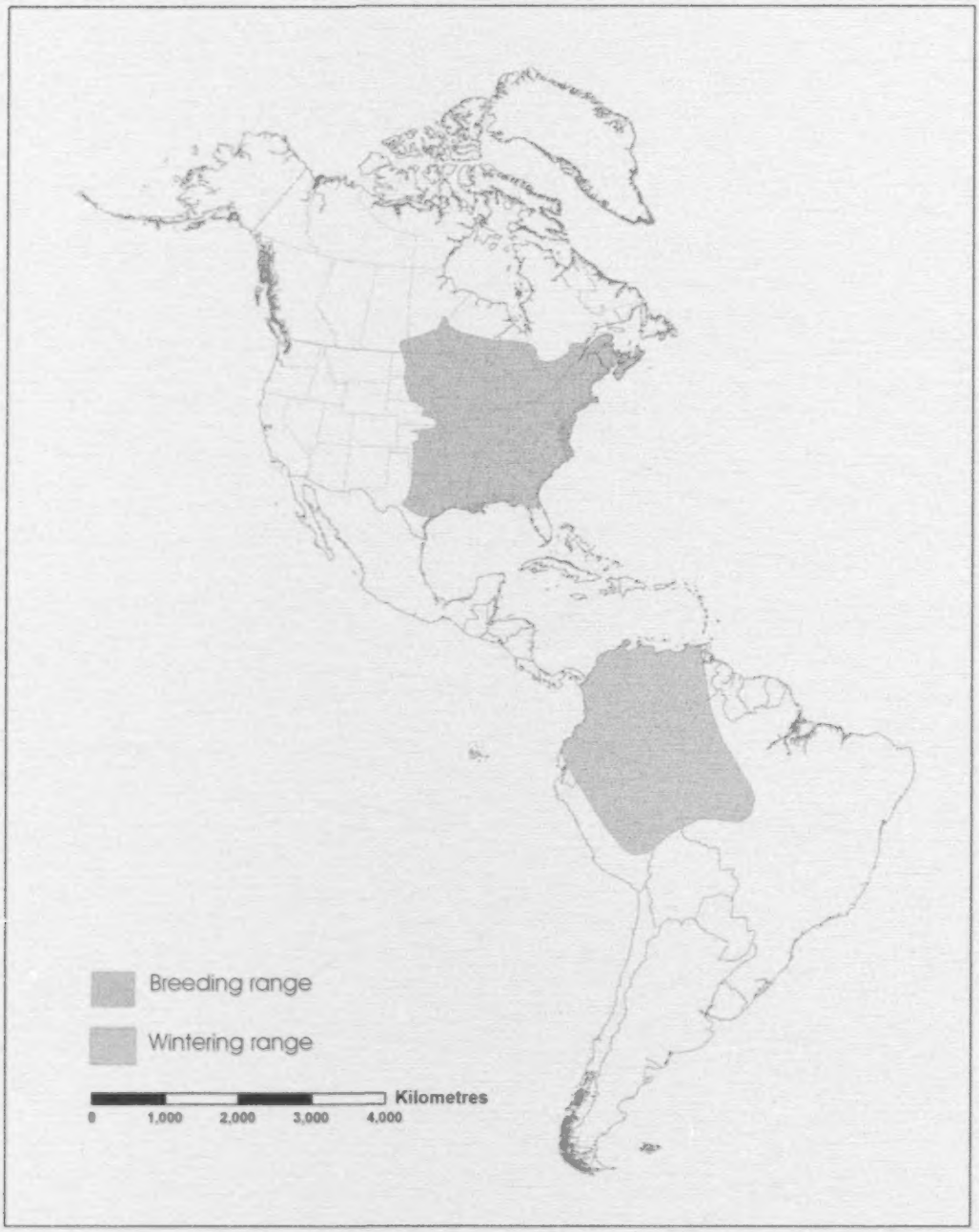

Figure 1. Global range of the Eastern Wood-pewee (based on Gauthier and Aubry 1995; Ridgely *et al.* 2003; Cadman *et al.* 2007; Bird Studies Canada [BSC] 2011a, b).

Figure 2. Canadian breeding range of the Eastern Wood-pewee (based on Gauthier and Aubry 1995; Cadman *et al.* 2007; BSC 2011a, b; Government of Saskatchewan 2011; BSC 2012).

The extent of occurrence in Canada is 2,090,000 km^2, as measured by a minimum convex polygon based on the NatureServe range map (Ridgely *et al.* 2003). The estimated index of area of occupancy (IAO) based on a 2 km x 2 km grid intersecting known areas of occupancy for the species cannot be calculated due to a lack of detailed information on the locations of all breeding sites, but it undoubtedly exceeds COSEWIC's minimum threshold of 2000 km^2.

Search Effort

Distributional data for the Eastern Wood-pewee in Canada mainly come from breeding bird atlas work conducted in the 1980s and in the 2000s in Ontario (Cadman *et al.* 1987; 2007), Québec (Gauthier and Aubry 1995, BSC 2011a), and the Maritimes (Erskine 1992; BSC 2012). Recent atlas projects have also been initiated in Manitoba (BSC 2011b). The Québec checklist program (Cyr et Larivée 1995) and the Breeding Bird Survey (BBS) in Canada also provide insight into the species' distribution in Canada.

HABITAT

Habitat Requirements

Breeding season

In Canada, the Eastern Wood-pewee breeds mostly in mature and intermediate-age deciduous and mixed forests (less often in coniferous forest) having an open understory (Ouellet 1974; Godfrey 1986; Peck and James 1987; Gauthier and Aubry 1995; Falconer 2010; Burke *et al.* 2011). It is often associated with forests dominated by Sugar Maple (*Acer saccharum*), elm (*Ulmus* sp.) and oak (*Quercus* sp.; Graber *et al.* 1974). It is usually associated with forest clearings and edges within the vicinity of its nest (Hespenheide 1971; Peck and James 1987).

A comparison of habitat use by the Eastern Wood-pewee in deciduous forest and conifer plantations in one study in southern Ontario found that in each habitat, territories had lower tree basal area, tree species diversity, and fewer pines than non-territory sites (Falconer 2010). Pewees were apparently selecting for fewer trees and greater openness in the forest—a structure that would favour bouts of aerial foraging activities.

In the Maritimes, an analysis of breeding bird atlas point count data suggests that pewees are strongly associated with mature poplar and hardwood forest, with weaker associations with older pine, hemlock and other forest types (M. Campbell unpubl. data). At the landscape scale in the Maritimes, pewees are associated with the presence of marshes, lakes, ponds and rivers, and negatively associated with harvested forest, human-occupied areas and roads (M. Campbell unpubl. data).

In West Virginia, the Eastern Wood-pewee selects habitat based on forest stand-level characteristics (elevation, size of stand, age, and ecological land type) and at the microhabitat level (tree stem density and tree species diversity; McDermott *et al.* 2010). The species can become abundant in pure hemlock stands that have experienced >60% mortality of trees resulting from chronic Hemlock Woolly Adelgid (*Adelges tsugae*) infestations (Tingley *et al.* 2002).

In Iowa, habitat suitability for this species increased rapidly with tree density, before levelling off or declining when densities approached 1600 trees/ha (Best and Stauffer 1986). In Virginia, the Eastern Wood-pewee was most abundant in forest stands of intermediate age with little understory vegetation (Crawford *et al.* 1981).

In some regions at least, the pewee reaches higher breeding densities in dry upland sites than in lowland forest (Peck and James 1987; Robbins *et al.* 1989; McCarty 1996; Newell and Rodewald 2011). Nesting in wet forests probably just reflects a preference for open space near the nest tree (Peck and James 1987).

Generally, size of forest fragments does not appear to be an important factor in habitat selection (Stauffer and Best 1980; Blake and Karr 1987, Robbins *et al.* 1989, Freemark and Collins 1992; Desrochers *et al.* 2010). However, the species is known to occur less frequently in woodlots with surrounding residential development than in those without houses (Friesen *et al.* 1995; Keller and Yahner 2007).

More than most other eastern flycatcher species, the Eastern Wood-pewee uses dead branches as hunting perches (Via 1970), which may be an additional habitat need.

Non-breeding season

During migration, various forested habitats are used, including woodland edges, early successional clearings, and primary and secondary lowland (and submontane) tropical forest, as well as cloud forest (Ridgely and Gwynne 1989; Stiles and Skutch 1989; Arendt 1992; Vidal-Rodriguez 1992). In Costa Rica, the species is reported from clearings and young second-growth, but not old second-growth or primary forest (Blake and Loiselle 1992; Powell *et al.* 1992). It is found in both dry and moist forest in Panama (Hespenheide 1980), and is reported from coastal and urban areas, farmland, forest edge, and dry and wet forests in the Caribbean (Amos 1991; Arendt 1992). It is reportedly most common from lowlands to elevations of 1500 m (Stiles and Skutch 1989; Howell and Webb 1995), but may be found as high as 2850 m (Fjeldså and Krabbe 1990; Vidal-Rodriguez 1992).

There is little information available on the habitat types occupied on the South American wintering grounds. It reportedly uses open forest (e.g., flooded riparian stands), shrubby habitats, edges of primary forest, but also occurs in interior forests where tree-fall gaps are present (Fitzpatrick 1980; Pearson 1980; Fjeldså and Krappe 1990; Stotz *et al.* 1992; Ridgely and Tudor 1994).

Habitat Trends

The current amount of suitable breeding habitat in Canada is much less than it was prior to European colonization. For example, in eastern Ontario, 70-80% of the original deciduous forest cover had been removed by the 1880s (OMNR 1997; Zhang and Guindin 2005). Similar historical perspectives are also apparent in southern Québec (Ouellet 1974; Li and Ducruc 1999; Gratton 2010).

Since European settlement, the overall extent of forest habitat in eastern Canada has mostly been increasing in recent decades, because of the regrowth of secondary forest on abandoned farmland, particularly in eastern Ontario (Larson *et al.* 1999) and parts of southern Québec outside the St. Lawrence Lowlands (Latendresse *et al.* 2008). Within the St. Lawrence Lowlands, however, habitat loss is still occurring (Jobin *et al.* 2007). In New Brunswick, a preliminary analysis of forest inventory data comparing the area of mature deciduous forest habitat, which is the type favoured by Eastern Wood-pewees, indicates a decline of about 18% between the 1980s and the 2000s (New Brunswick Department of Natural Resources unpubl. data 2012). Declines in mature

mixed forest habitat were greater, ranging from 34-68%, but such habitat is less favoured by pewees. The declines noted above reflect changes in the age structure of the forest community as a result of forest management planning favouring shorter rotation periods that are increasingly replacing mature forest with young forest (S. Makepeace *fide* Sabine pers. comm. 2012).

Large tracts of homogenous deciduous forests with little broken canopy probably reduce habitat suitability for pewees (Ahlering and Faaborg 2006; Friesen pers. comm. 2012). Hence, as second-growth forests mature to a climax successional stage, it is possible that the quality of pewee habitat naturally declines somewhat, especially in the absence of forest management. However, little is known about how much unmanaged habitat in Canada might be returning to a climax condition, nor the extent to which this might be affecting pewee populations or demographics.

On the wintering grounds, the Eastern Wood-pewee uses forest patches and second growth, and may be less affected by loss of contiguous tropical forest than some other species (McCarty 1996). However, virtually nothing is known about the species' wintering habitat requirements. A recent study, which examined change in forest area in Latin America between 2001 and 2010, found that deforestation rates were particularly severe in South America, especially within the moist forest biome (Aide *et al.* 2012).

BIOLOGY

Few studies have been conducted specifically on the Eastern Wood-pewee. McCarty (1996) is the general source of information for North America. While limited to rather specialized situations in Ontario, the most complete source of information on breeding biology, productivity, and habitat associations in Canada is provided by Falconer (2010).

Reproduction

Age of first reproduction is unknown but individuals probably breed at 1 year (McCarty 1996). The Eastern Wood-pewee is generally monogamous (McCarty 1996), but polygyny also occurs (11% of 53 nests in southern Ontario; Falconer 2010). Breeding activity extends from late May through August and occasionally September (McCarty 1996; Falconer 2010). Double broods are not infrequent (Falconer 2010).

In southern Ontario, nests tend to be built in large, mature trees (Falconer 2010). Nests are well camouflaged and located on top of a horizontal limb (often a dead limb) in a living tree, well out from the trunk, at heights ranging from 2 to 21 m (Peck and James 1987), and usually at the higher end of this range.

In Ontario, clutch size ranges up to 4 eggs but generally averages 3 eggs (62% of 103 nests; Peck and James 1987). In Ontario, egg dates for 94 nests ranged from 3 June to 14 August (Peck and James 1987). In Manitoba, pewees initiate clutches between 11 June and 6 July, with an average initiation date of 23 June (Underwood *et al.* 2004). The incubation period lasts about 12-13 days (Bendire 1895 in McCarty 1996; Knight 1908 in McCarty 1996; Bent 1942). Nestlings fledge after about 16-18 days (Bendire 1895 in McCarty 1996; Knight 1908 in McCarty 1996; Bent 1942; Sandusky 1977).

In his study in southern Ontario, Falconer (2010) found that nest success increased later in the breeding season, and nests in deciduous forest were twice as likely to be successful as those in pine plantations owing to differences in predation rates. Data from Minnesota, Wisconsin, and Iowa indicate that nesting success in fragmented landscape is 43% (Daily Survival Rate = 0.974 ± 0.006; n=90 nests; n=1605 observation days; Knutson *et al.* 2004).

Survival

The maximum recorded life-span is about 7 years (Clapp *et al.* 1983), and the species' age at first breeding is 1 year (McCarty 1996). Generation time for the Eastern Wood-pewee, which corresponds to the average breeding age in the population, is estimated at 2 to 3 years.

Movements/dispersal

Little research has been carried out on the Eastern Wood-pewee's fidelity to breeding sites (McCarty 1996). Of nine adults banded on their breeding sites in Illinois, two returned the following year (Robinson 1992). No information exists on local movements on the breeding grounds and/or dispersal after the nesting season.

About 95% of spring migration into southern Canada extends from about 10 May to about 10 June (Long Point Bird Observatory unpubl. data). Fall migration extends from about 20 August to 20 October. The species is generally solitary during migration (Stiles and Skutch 1989; Ridgely and Tudor 1994). Migration probably occurs mostly at night (McCarty 1996).

The Eastern Wood-pewee migrates primarily through the eastern and central U.S., south through the Gulf lowlands of Mexico, on both slopes from Chiapas south through Central America (Binford 1989; Ridgely and Gwynne 1989; Stiles and Skutch 1989; Howell and Webb 1995). It is also known to cross the Caribbean, passing through the West Indies (McCarty 1996).

Diet and Foraging Behaviour

No studies on feeding behaviour or diet have been conducted in Canada and most studies come from the United States (McCarty 1996). The pewee's diet consists primarily of small, flying insects that are 'hawked' in short flights from a perch in the subcanopy (Via 1979; McCarty 1996).

During the breeding season, the Eastern Wood-pewee feeds on a variety of small (mostly <15 mm) flying insects, including Diptera, Homoptera, Lepidoptera, Hymenoptera, Coleoptera, Orthoptera, Plecoptera and Ephemeroptera (Johnston 1971; Gray 1993; Sample *et al.* 1993). Foraging habits and diet during migration and in winter appear to be similar to those on the breeding grounds (Fitzpatrick 1980).

Interspecific Interactions

Few direct observations of predation on adults or nests of the Eastern Wood-pewee are available (McCarty 1996). In southern Ontario, Falconer (2010) reported an observation of a Blue Jay (*Cyanocitta cristata*) taking nestlings from a nest. He also suggested that Red Squirrels (*Tamiasciurus hudsonicus)* and flying squirrels (*Glaucomys* sp.) were potential predators. In Ohio, Blue Jays, American Crows (*Corvus brachyrhynchos*), owls, Eastern Chipmunks (*Tamias striatus*), Grey Squirrels (*Sciurus carolinensis*), and Raccoons (*Procyon lotor*) were regarded as potential predators (Newell and Rodewald 2011). During the breeding season, male pewees also show aggression towards Red-winged Blackbirds (*Agelaius phoeniceus*) and Common Grackles (*Quiscalus quiscula*) within their territories, suggesting that these species could depredate eggs or nestlings (Bent 1942; Nice 1961 in Graber *et al.* 1974).

The Eastern Wood-pewee is a rare host for the Brown-headed Cowbird (*Molothrus ater*; McCarty 1996), with low parasitism rates in Ontario (5.1%, n=117 nests; Peck and James 1987) and Manitoba (0%, n = 20 nests; Underwood *et al.* 2004).

Home Range and Territory

In a study in southern Ontario, Eastern Wood-pewee territories averaged 1.70 ± 0.33 ha (n=26 pairs) in deciduous forests and 1.83 ± 0.36 ha (n= 27 pairs) in pine plantations; there was no significant difference between habitat types (Falconer 2010). When both habitats were combined, territory size averaged 1.76 ± 0.24 ha (Falconer 2010).

Behaviour and Adaptability

On the breeding grounds, Eastern Wood-pewees can benefit from forest management practices such as selective harvest, which creates small openings in the canopy (Clark *et al.* 1983; Wilson *et al.* 1995; Artman *et al.* 2001; Campbell *et al.* 2007; Greenberg *et al.* 2007; Burke *et al.* 2011). A positive response may be due to higher levels of flying insect prey and/or their greater visibility in forest gaps. A study conducted in the southeastern U.S. (Arkansas, South Carolina and West Virginia) suggested that populations of Eastern Wood-pewees remained relatively stable over a 40-year scenario in landscapes managed under different forest management treatments (i.e., unmanaged, 60,120, and 180-acre cut size, and no-limit cut size; Mitchell *et al.* 2008). This suggests that the species shows some flexibility in its response to forest habitat management.

In southern Ontario, Falconer (2010) found that the presence of mature trees was important for nest-site selection. He suggested that maintaining large, mature trees (> 40 cm diameter at breast height in deciduous forest and > 32 cm in pine plantation), along with basal areas of 23 - 24 m^2 ha^{-1} (in both habitats), should provide adequate nesting requirements for wood-pewees.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

North American Breeding Bird Survey (BBS)

The BBS is designed to monitor North American breeding bird populations (Environment Canada 2010; Sauer *et al.* 2011). Breeding bird abundance data are collected by volunteers at 50, 400-m radius stops spaced at 0.8 km intervals along permanent 39.2 km routes on roadsides (Sauer *et al.* 2011). In Canada, the surveys are mostly conducted in June (i.e., during the height of the breeding period of most bird species). Surveys start one half hour before sunrise.

The main strengths of the BBS are that data from across much of North America have been collected according to a single standardized method, and surveys employ random start points and directions, thus enhancing regional representation of the avifauna (roadside bias notwithstanding; Blancher *et al.* 2007). Analysis of BBS data are now based on a hierarchical Bayesian model (see Sauer and Link 2011 and Environment Canada 2012). In the case of the Eastern Wood-pewee, the BBS covers most of the species' breeding range, and short- and long-term trends should correspond closely to actual population changes. Moreover, due to its highly recognizable song, the Eastern Wood-pewee should be readily detected wherever it occurs along BBS routes.

Étude des populations des oiseaux du Québec (ÉPOQ)/ Study of Québec Bird Populations (SQBP)

In Québec, the ÉPOQ (SQBP) database, which has been managing bird checklists submitted by thousands of volunteers since 1955 (accumulating more than 500,000 checklists), is another reference for determining Eastern Wood-pewee population trends (Cyr and Larivée 1995; Larivée 2011). The ÉPOQ database covers all regions south of the 52nd parallel, especially the St. Lawrence Lowlands, where the species is most abundant (Cyr and Larivée 1995). The abundance index is one of two abundance measures produced by ÉPOQ and is a measure of the number of birds observed based on the number of checklists submitted.

The strength of this survey lies in the fact that it covers the entire breeding range of the species in Québec (Cyr and Larivée 1995). However, the current analysis method does not take observation effort (i.e., the number of observers per checklist) into account, nor weather conditions, nor spatial variation in observation effort, but simply the number of hours of observation (Cyr and Larivée 1995). Nonetheless, the trends produced by the ÉPOQ database are correlated with those of the BBS and generate adequate trend assessments (Cyr and Larivée 1995; Dunn *et al.* 1996).

Ontario Breeding Bird Atlas (OBBA)

The Ontario Breeding Bird Atlas compared the distribution of breeding birds between 1981-1985 and 2001-2005, and is an important source of information on the status of the Eastern Wood-pewee in Ontario (Cadman *et al.* 2007). The data were gathered by volunteers who visited representative habitats within 10 km x 10 km squares for at least 20 hours during the breeding period (Cadman *et al.* 2007). The percent change in the distribution of the Eastern Wood-pewee in Ontario over a period of 20 years was calculated by comparing the percentage of the squares occupied in the first atlas period to the percentage occupied in the second atlas period, adjusting for observation effort (Blancher *et al.* 2007; Cadman *et al.* 2007).

The main limitation of this method is that the analysis comparing occupancy rates between the two atlas periods underestimates the change in actual population size for common, widespread species like the Eastern Wood-pewee (Francis *et al.* 2009). Differences in effort between the two atlases may also have led to some biases in estimating change (Blancher *et al.* 2007), because effort was not standardized between the two periods, and there can be important differences in efficiency of effort that cannot be captured by adjusting for quantity of effort. A major limitation of atlases is that they are typically repeated only at 20-year intervals, which means they cannot detect changes in population status during intervening periods (Francis *et al.* 2009).

Breeding Bird Atlases in other provinces

Using the same methodology as for the OBBA, data collection for a second atlas has been completed for the Maritimes for the period 2006-2010, which provides comparison with the first atlas, conducted from 1986-1990 (BSC 2012). In Québec, a second breeding bird atlas was started in 2010, but comparisons of results with the previous atlas conducted 20 years earlier (Gauthier and Aubry 1995) will not be available until 2014 (BSC 2011a). A first atlas project was also initiated in 2010 in Manitoba, which will provide results in 2014 (BSC 2011b).

A breeding bird atlas for Saskatchewan began in the 1970s and was completed in 1996 (Smith 1996). It employed a different methodology than was adopted by other provinces. Rather than engage in a massive field effort, it drew mostly upon several existing databases, including the Breeding Bird Survey, bird banding data from the Canadian Wildlife Service, and nest records from the Prairie Nest Records Scheme (Smith 1996).

Ontario Forest Bird Monitoring Program (FBMP)

Coordinated by the Canadian Wildlife Service, the Forest Bird Monitoring Program (FBMP) began in Ontario in 1987 to provide information on population trends and habitat associations of birds that breed in the forest interior (Ontario Forest Bird Monitoring 2006). Each year, between 50 and 150 sites are surveyed by volunteers, who make two 10-minute visits to five point count stations per site. The program was designed to investigate spatial and temporal patterns for forest birds, with monitoring sites selected in off-road sites in core areas of large, mature forests that are typically protected from active forest management. Because other kinds of forest habitat are not sampled and because of limited geographical coverage, the program's results are not representative of the overall landscape (Francis *et al.* 2009). Hence, for the Eastern Wood-pewee, which prefers intermediate-age forests, the FBMP may provide a biased sample. Trend analysis for Eastern Wood-pewee is currently available for the period 1987-2010 (R. Russell unpubl. data 2011).

Migration Monitoring

Several field stations associated with the Canadian Migration Monitoring Network provide counts of Eastern Wood-pewees during spring and/or fall migration. The longest-running station is Long Point Bird Observatory (LPBO), located on the north shore of Lake Erie, which has been in operation since 1961 and precedes the BBS by a decade. In addition to banding, volunteers also carry out a standardized daily count of all migrating birds, and keep track of all other migrants they observe throughout the day. Spring and fall population indices for the Eastern Wood-pewee for LPBO are calculated annually (BSC 2011c). Population indices are also available for other stations, but none span more than two decades. A major weakness of migration monitoring is that relatively little is currently known about the breeding origins of the birds being sampled.

Abundance

Based on BBS data from 1987-2006, the Eastern Wood-pewee reaches its highest Canadian abundance in southern Ontario (Figure 3). Based on all available information, there are roughly 435,000 breeding adults (217,500 mated pairs) in Canada (see Table 1). These birds are concentrated in Ontario (69%), Québec (10%) and Manitoba (9%); the rest are distributed at lower densities in other provinces (Table 1).

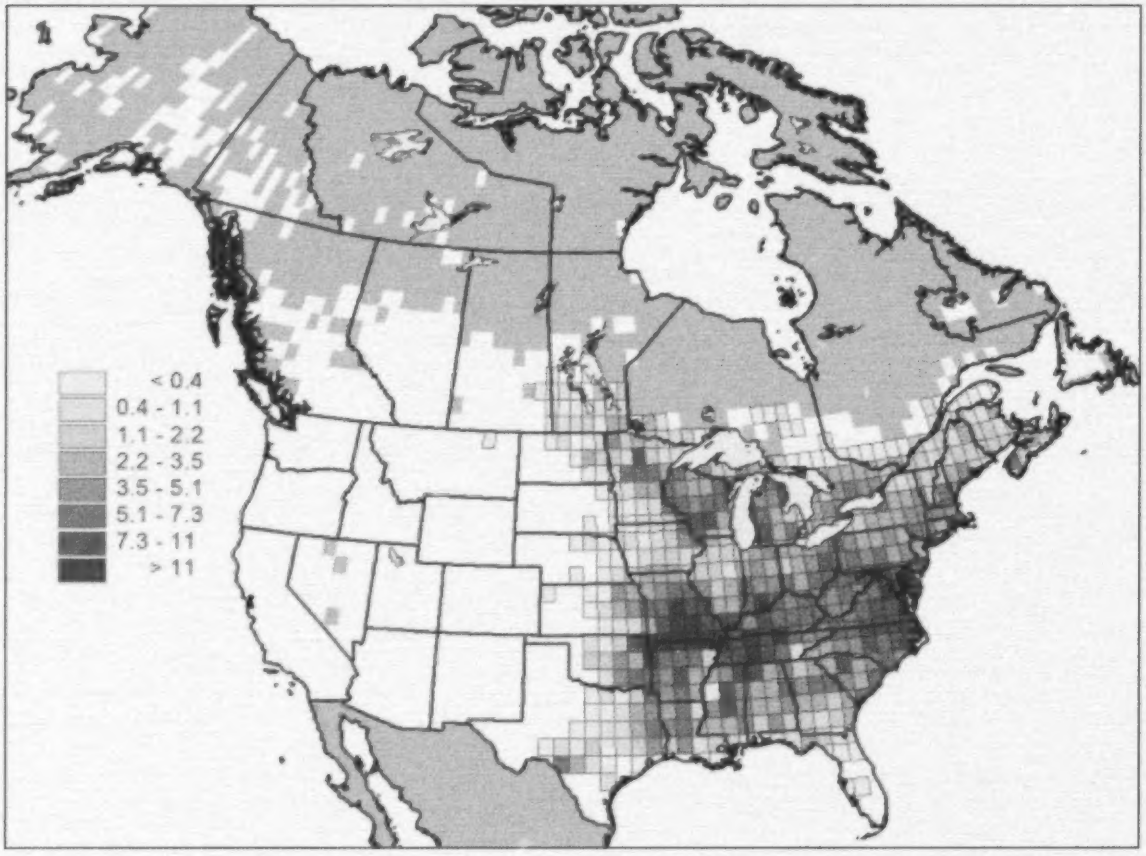

Figure 3. Relative abundance of Eastern Wood-pewees breeding in North America, based on BBS data calculated for each latitude and longitude degree block from 1987-2006, in relation to the proportion of the breeding range surveyed by the BBS. Grey areas = not surveyed by BBS; white areas = surveyed, but no Eastern Wood-pewees detected (Environment Canada 2011).

Table 1. Population size estimates of the numbers of Eastern Wood-pewees breeding in Canada based primarily on Breeding Bird Survey data (Blancher *et al.* 2007, updated by P. Blancher unpubl. data 2011).

Province[1]	Population Size (adults)	% of Global Population
ON[2]	300,000	5.3
QC	45,000	0.8
MB	40,000	0.7
NS	30,000	0.5
NB	18,000	0.3
PE	2,700	0.05
Total	**435,000**	**7.7**

[1] Too few birds were recorded on BBS routes in Saskatchewan to provide a population estimate.
[2] Ontario estimate is based on breeding bird atlas point counts (2001-2005). The atlas estimate is based on a far greater number of point counts (including off-road counts) than the BBS, which increases the reliability of the atlas estimate.

Fluctuations and Trends

The Eastern Wood-pewee has probably always been fairly common and widespread within its current range in Canada (Wintle 1896; Dionne 1906; Ouellet 1974; Godfrey 1986; Gauthier and Aubry 1995; Cadman *et al.* 2007). Population trends are, however, only available since the 1970s.

North American Breeding Bird Survey

In Canada, long-term BBS data show a significant decline of about 2.9% per year (95% CI: -3.4, -2.5) between 1970 and 2011, which corresponds to an overall decline of 70% over the last 40 years (Figure 4, Table 2; Environment Canada unpubl. data). In the most recent 10-year period (2001 to 2011, or roughly three generations), BBS data show a significant decline of about 2.8% per year (95% CI: -3.7, -1.9; Table 2), which represents a 25% decline over the last 10 years in Canada (95% CI: -31.4%, -17.5%). Populations declined significantly in Manitoba, Ontario, Québec, New Brunswick and Nova Scotia/Prince Edward Island for the period 1970-2011, with a more pronounced decline in Québec and New Brunswick (Table 2). For the more recent period (2001-2011), short-term declines are also apparent, and again tend to be more pronounced in the eastern part of the country (Table 2).

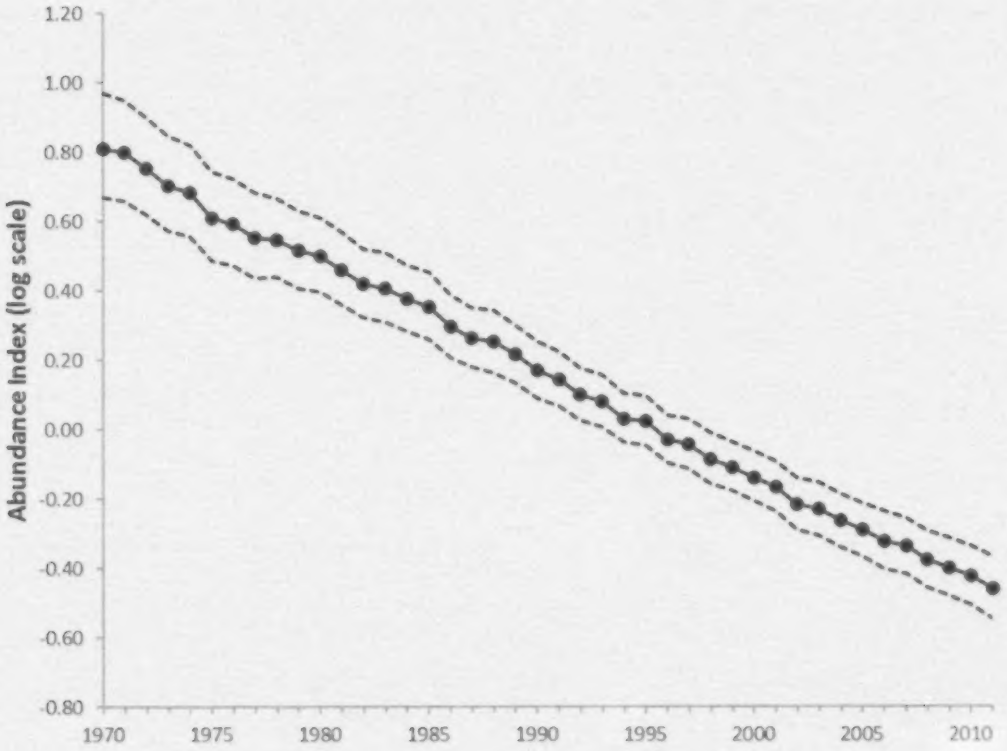

Figure 4. Eastern Wood-pewee annual abundance indices for Canada between 1970 and 2011, based on a hierarchical Bayesian model of Breeding Bird Survey data, plotted on a log-scale (Environment Canada unpubl. data 2012). Dotted lines correspond to the 95% upper and lower credible intervals.

Table 2. Average annual population trends (and 95% lower [lcl] and upper [ucl] credible intervals) for the Eastern Wood-pewee in the long- and short-term based on BBS surveys (Environment Canada unpubl. data 2012). Results in bold are statistically significant.

	1970-2011			2001-2011		
Region	Annual Rate of Change (%/yr)	lcl	ucl	Annual Rate of Change (%/yr)	lcl	Ucl
Canada	**-2.93**	-3.39	-2.48	**-2.81**	-3.65	-1.93
Manitoba	**-1.85**	-3.83	-0.03	-1.97	-6.02	1.22
Ontario	**-2.59**	-3.25	-1.97	**-2.51**	-3.54	-1.43
Québec	**-4.43**	-5.49	-3.40	**-4.37**	-6.33	-2.32
New Brunswick	**-3.84**	-4.92	-2.63	**-4.32**	-8.33	-0.40
Nova Scotia & Prince Edward Island	**-1.85**	-2.99	-0.76	-1.96	-4.88	0.50

Ontario Breeding Bird Atlas (OBBA)

A comparison of the species' probability of observation in Ontario from the first (1981-1985) to the second (2001-2005) atlas period showed no statistically significant change across the province as a whole (Cadman *et al.* 2007). Indeed, there was an overall, non-significant, increase of 9%. This result contrasts with the significant negative trend obtained from the BBS data. However, by region the probability of observation decreased significantly in the Lake Simcoe-Rideau area (-6%) and in the Southern Shield (-15%) and decreased non-significantly in the Carolinian region (-6%) (Cadman *et al.* 2007; Figure 5). These declines could have been balanced somewhat by a shift in the species' distribution from the Southern Shield region northward into the adjacent Northern Shield region where the Eastern Wood-pewee showed a 75% increase in probability of observation (Cadman *et al.* 2007).

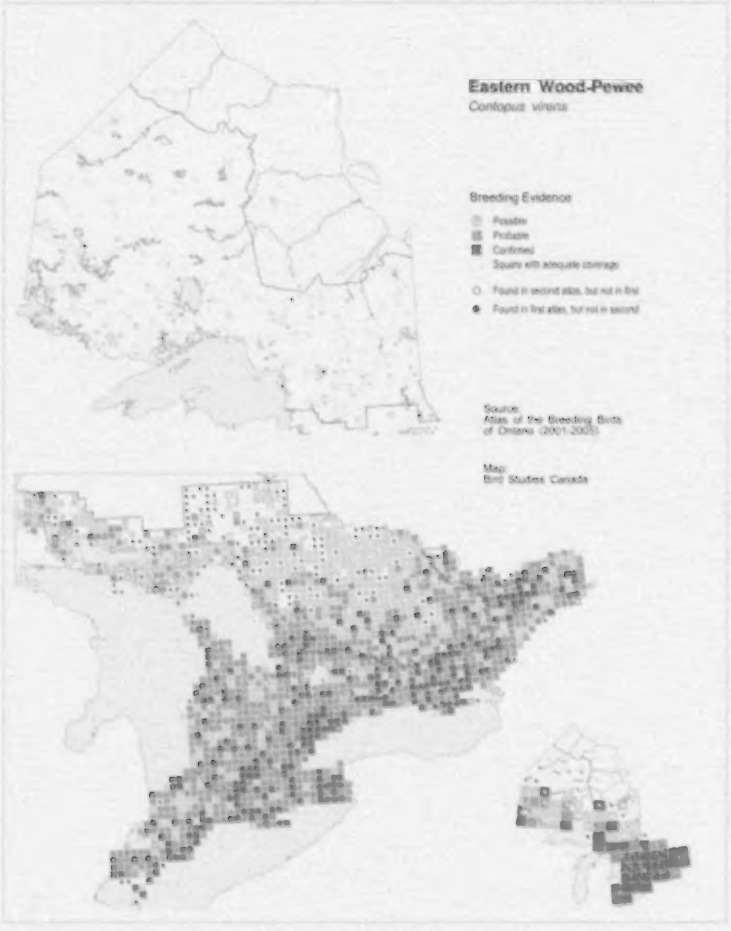

Figure 5. Ontario distribution of the Eastern Wood-pewee during the period 2001-2005, based upon atlas data (reproduced with permission from Cadman *et al.* 2007). Squares with black dots are those in which the species was found in the first atlas period (1980-1985), but not in the second (2001-2005). Squares with yellow dots correspond to those where the species was found only in the second atlas.

Maritimes Breeding Bird Atlas (MBBA)

Preliminary analyses comparing the probability of observation of Eastern Wood-pewees within their Maritime range after 20 hours of observation in the first and second Atlas periods indicate significant declines over the last 20 years (Figure 6). The probability of observation declined from 0.50 to 0.40, which yields a statistically significant average annual decline of 1.02% over the 20-year period (or roughly a 10% decline over 10 years). The decline was driven mainly by New Brunswick (-1.6% per year; M. Campbell unpubl. data; S. Makepeace *fide* Sabine pers. comm. 2012).

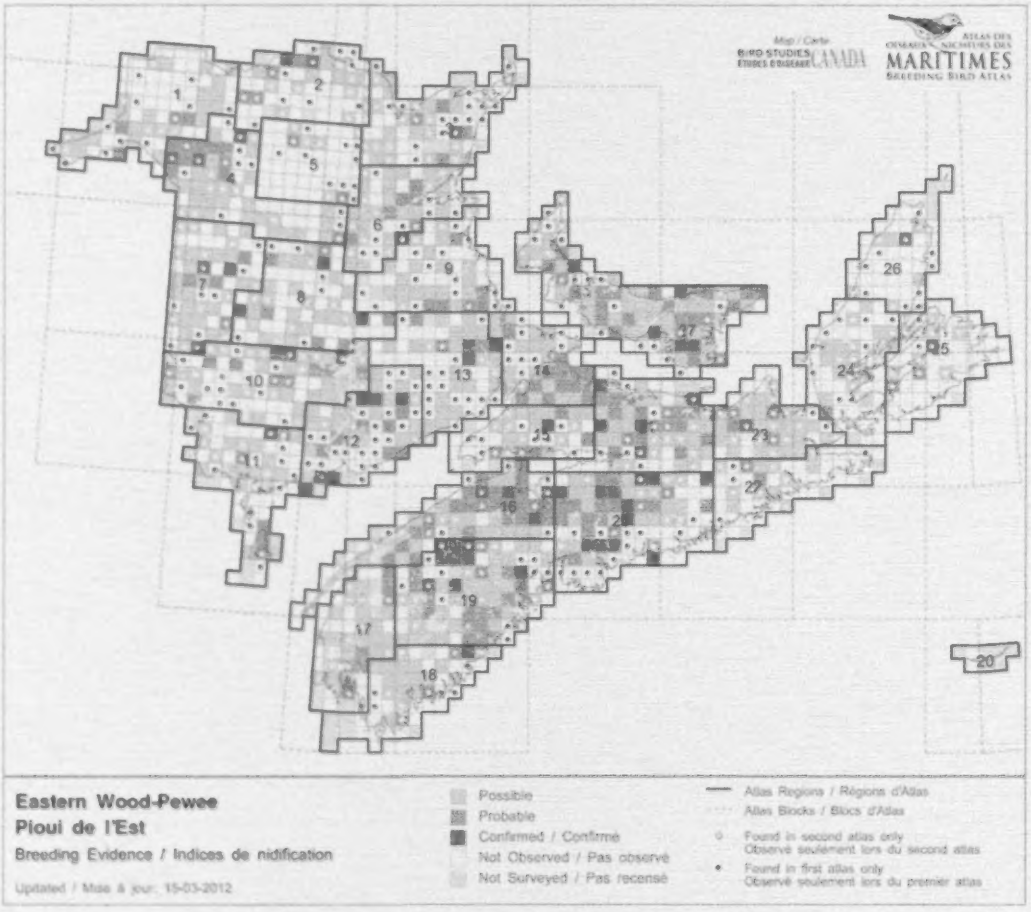

Figure 6. Distribution of the Eastern Wood-pewee in the Maritimes during the period 2006-2010 (reproduced with permission from BSC 2012). Squares with black dots are those in which the species was found in the first atlas period (1986-1990), but not in the second (2006-2010). Squares with yellow dots are those in which the species was found in the second atlas period but not in the first.

Étude des populations des oiseaux du Québec (ÉPOQ)/ Study of Québec Bird Populations (SQBP)

The ÉPOQ database shows a significant long-term decline in Eastern Wood-pewee abundance in Québec of 0.5% per year (R^2= 0.62; P ≤ 0.001; Figure 7) between 1970 and 2009, representing a 17% decline over 39 years. For the 10-year period from 2000-2009, the short-term trend was stable, with a non-significant decline of 0.06% per year (R^2= 0.006; P ≥ 0.05).

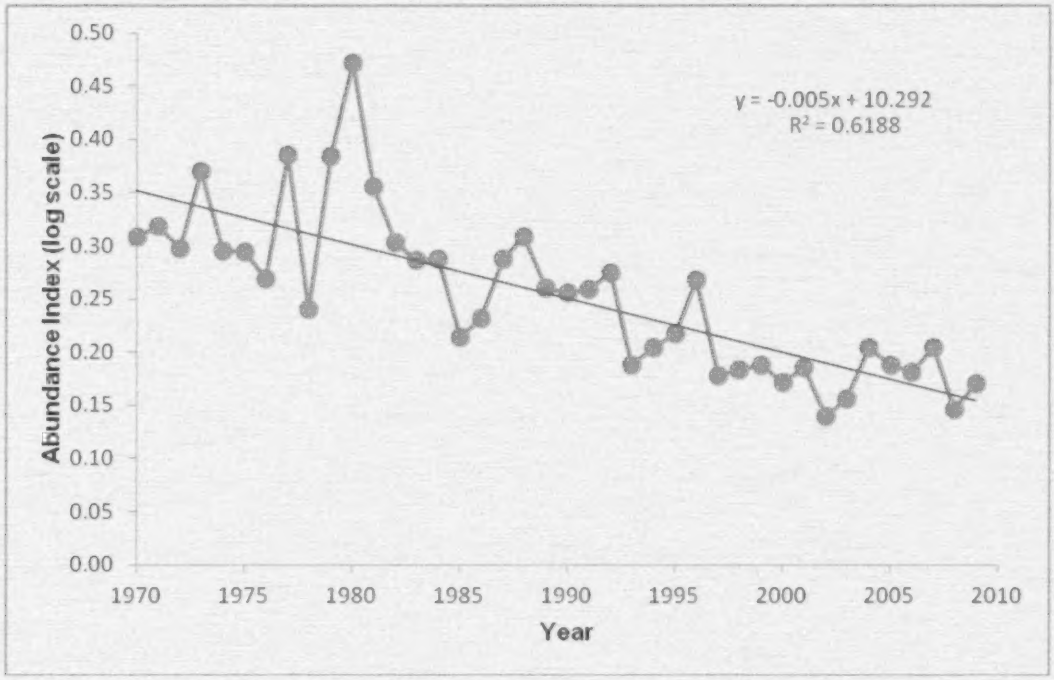

Figure 7. Annual indices (log scale) of population change for the Eastern Wood-pewee in Québec between 1970 and 2009, based on ÉPOQ data (Larivée 2011). Only checklists produced between May 15 and July 15 were used in the analysis.

Ontario Forest Bird Monitoring Program (FBMP)

The long-term FBMP annual trend estimate for the Ontario population of the Eastern Wood-pewee in interior, mature forests shows a near-significant decline of 2.3% per year (n = 201 sites with sufficient sample size; 0.05 < p < 0.10; 95% CI= -4.9, 0.3) between 1987 and 2010 (R. Russell unpubl. data 2011). Regionally, the trend was negative for central Ontario, with a significant decline of -4.7% per year for the same time period (n= 52 sites; p<0.05; CI: -8.1, -1.1). A non-significant decline was estimated for southwestern Ontario (-1.7% per year; n= 149 sites; p>0.05; CI: -4.8, 1.4). A 10-year trend estimate is currently unavailable.

Migration Monitoring

Long-term migration data collected at Long Point, Ontario from 1961-2010 detected a statistically significant increase of 1.8% per year in the fall ($p<0.001$) and 1.5% per year in spring ($p<0.001$; T. Crewe unpubl. data; see Figure 8). For the corresponding long-term BBS time period (1970-2010), the LPBO annual average trends were also strongly positive (2.0%; $p<0001$ for fall; and 1.6%; $p<0.01$ for spring). The most recent 10-year trend estimates for 2000-2010 show an average non-significant decline of -2.6% ($p=0.34$) in the fall, but a statistically significant increase of 6.6% per year ($p<0.05$) in spring. There is large annual variation in population indices at Long Point, especially in spring (Figure 8). Short-term trend estimates based on migration monitoring are heavily influenced by the particular window of years that is selected.

Also available from T. Crewe (unpubl. data) are relatively short-term trend estimates (based on 9-18 years of data) from the following other migration monitoring stations in Canada: Delta Marsh Bird Observatory, MB (1993-2010; fall only; -4.1% per year; $p = 0.02$); Innis Point Bird Observatory, ON (1997-2010; spring only; -6.0%; $p = 0.05$); Prince Edward Point Bird Observatory, ON (2001-2010; fall only; -7.0%; $p = 0.08$); Ruthven Park, ON (1998-2010; spring = -0.5%; $p > 0.8$; fall = -0.4%; $p > 0.8$). While all these recent estimates point to recent declines, care again needs to be taken when interpreting population changes based on short-term data sets that have high annual variation.

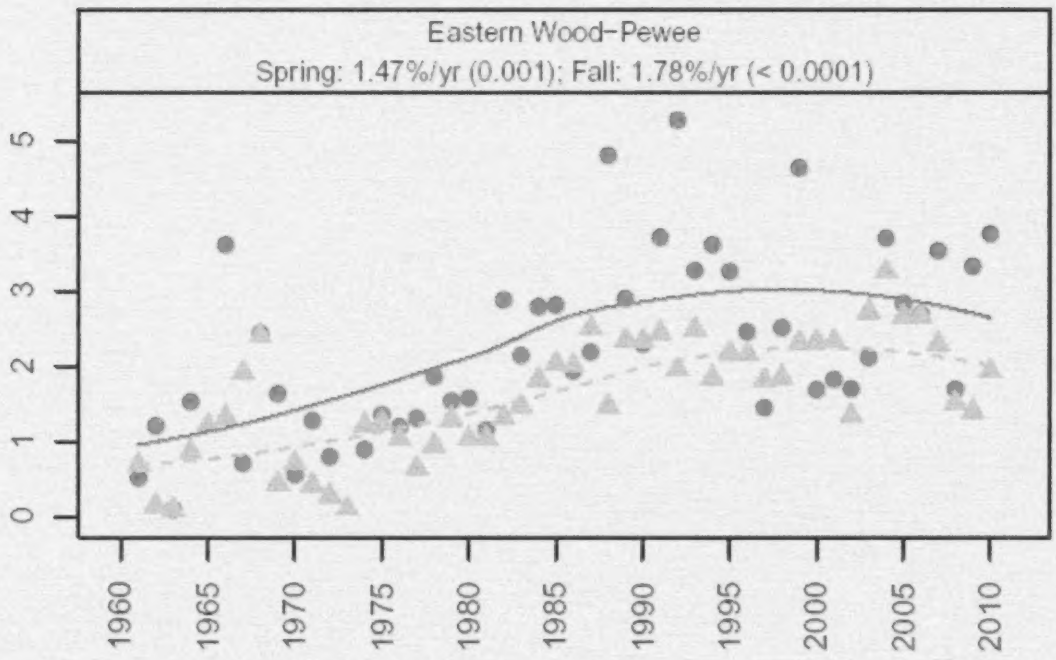

Figure 8. Long-term trends in spring and fall migration indices of Eastern Wood-pewees recorded at Long Point Bird Observatory, Ontario (1961-2010). Spring indices and trend are denoted by green circles and the solid green line. Fall indices and trend are denoted by orange triangles and the orange dashed line (graphic courtesy of T. Crewe unpubl. data 2011).

Population Trend Summary

BBS data for Canada and most provinces indicate a significant decline in the population of Eastern Wood-pewees for the period 1970-2011. For Canada and most eastern provinces, these trends seem to hold also for the more recent period from 2001-2011. The negative trend pattern obtained from the BBS also corresponds somewhat with results from other databases such as ÉPOQ (Québec) and FBMP (Ontario).

While evidence for a province-wide decline in Ontario is not apparent with the breeding bird atlas results, results suggest that declines have occurred in the southern part of the province, whereas increases have occurred at the northern edge of the species' breeding range, where the species is uncommon and BBS coverage is relatively weak. Unlike BBS results, LPBO results from counts of spring and fall migrants suggest an overall increasing population trend since 1961, with relatively more stable levels occurring from 2000-2010.

For the Eastern Wood-pewee, the lack of strong concordance of trend results between the various monitoring programs is difficult to reconcile, and points to the existence of biases among programs. In 2008, the Ontario Ministry of Natural Resources led a scientific review panel that assessed the relative strengths of various

kinds of bird monitoring programs for each species in Ontario, based on trend precision, survey coverage, survey design, and overall trend reliability (Francis *et al.* 2009). For the Eastern Wood-pewee, the panel concluded that the BBS was the most reliable monitoring program. BBS is highly standardized, covers the majority of the breeding range of the species, is representative of regional habitat cover, and shows lower annual statistical variance than estimates from other programs.

Rescue Effect

In the event of the extirpation of the Canadian population, immigration of birds from the central and northern United States is likely. However, the potential for continued rescue is decreasing. The population in the United States shows a persistent decline in the core of the species' breeding range between 1966-2010 (1.2%/year, -1.4, -1.1 CI, n= 2099 routes) as well as in most states bordering the eastern Canadian provinces (Sauer *et al.* 2011; Figure 9).

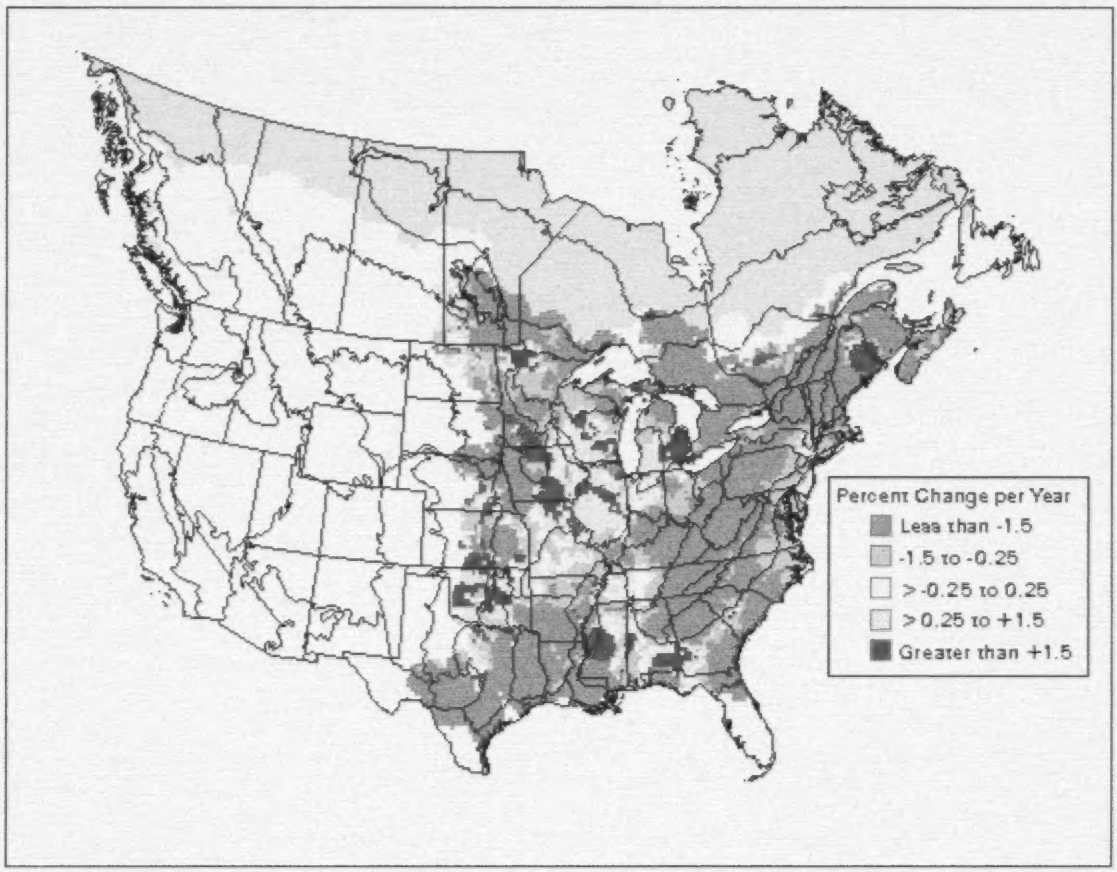

Figure 9. BBS trend map for Eastern Wood-pewee in the United States and Canada for the period from 1966 to 2010 (Sauer *et al.* 2011).

THREATS AND LIMITING FACTORS

Threats and limiting factors for Eastern Wood-pewees on the breeding grounds are poorly known (McCarty 1996). There is also little documented information on threats and limiting factors on the wintering grounds or during migration (McCarty 1996). Because Eastern Wood-pewees spend most of the year in South America and substantial time in migration, some of the key threats are likely operating outside Canada.

Habitat Loss/degradation

Outright loss of suitable forested habitat does not appear to be a significant issue across most of the pewee's Canadian breeding range, though some regions like New Brunswick are seeing losses in mature forest cover owing to forest management (see **Habitat trends** section).

The species does not appear to be very sensitive to forest fragmentation effects (Blake and Karr 1987; Robbins *et al.* 1989; Freemark and Collins 1992; Desrochers *et al.* 2010). Generally, size of forest fragments also does not appear to be an important factor affecting habitat selection by Eastern Wood-pewees (Stauffer and Best 1980; Blake and Karr 1987; Robbins *et al.* 1989; Freemark and Collins 1992). However, in Nebraska, the Eastern Wood-pewee was generally not present in regions with <24% forest cover (Perkins *et al.* 2003).

Development for human habitation can negatively affect the species' abundance in an area. In Ontario and Pennsylvania, pewees occur less frequently in woodlots with surrounding development than in those without houses (Friesen *et al.* 1995; Keller and Yahner 2007). A preliminary analysis of breeding bird atlas data in the Maritimes also indicated negative effects were associated with human-occupied areas and roads (M. Campbell unpubl. data). Likewise, in another study (in Ohio), pewee density in a forested urban environment was found to be lower than in outlying natural forests (Beissinger and Osborne 1982).

Changes in forest habitat supply and/or quality could have profound effects on survivorship of wintering populations of pewees. However, little is known about the pewee's habitat requirements outside the breeding period, particularly on its South American wintering grounds. A recent study that examined change in forest area in Latin America between 2001 and 2010 found that deforestation rates were particularly severe in South America, especially within the moist forest biome (Aide *et al.* 2012).

Large-scale Changes in Availability of Aerial Insects

Since at least the mid-1980s, many North American birds that specialize on a diet of flying insects have been experiencing widespread population declines (Nebel *et al.* 2010). As has been suggested for other aerial insectivores, Eastern Wood-pewee populations could be negatively affected by a possible change in the availability of

insect prey (Nebel *et al.* 2010). There are many possible causes of changes in insect food supply, including an increase in decalcification of forest soils and aquatic ecosystems brought about by acid precipitation, and climate-change effects that may be causing asynchrony between the timing of insect emergence and the breeding season of aerial insectivores (Nebel *et al.* 2010). At the more local level, Eastern Wood-pewees can also be adversely impacted by widespread spraying for Gypsy Moths (*Lymantria dispar*), because the spray kills other non-target insects that serve as food (Sample *et al.* 1993; Whitmore *et al.* 1993).

While this threat has the potential to be severe and widespread, little is known about the status or trends of populations of flying insects within the pewee's breeding or wintering ranges.

Mortality During Migration and/or Wintering

Sillett and Holmes (2002) suggested that mortality in long-distance migratory birds, such as the Eastern Wood-pewee, may be occurring mostly via processes acting during the non-breeding season. For example, severe storms can kill migrants over the Gulf of Mexico, including Eastern Wood-pewees (Wiedenfeld and Wiedenfeld 1995). Indeed, long-distance migrants that originate in Canada and winter in South America are generally declining more strongly than shorter-distance migrants (North American Bird Conservation Initiative Canada 2012). While the mechanisms that are driving this pattern are largely unknown, poor annual survivorship stemming from factors on the wintering grounds (or during migration) has the potential to present a high level of threat in terms of scope and severity.

Nest Predation

The only study that assessed reproductive success of the Eastern Wood-pewee in Canada found a high rate of nest predation (Falconer 2010). In this 2-year study in central Ontario, daily survival rate (DSR) and period survival (PS), assuming a 32-day nesting period, were greater in deciduous forests (DSR= 0.997 [0.967-0.985 CI], PS= 47.5%) than in pine plantations (DSR= 0.959 [0.946-0.968 CI], PS= 26.2%; Falconer 2010). High rates of nest predation by Blue Jays and Red Squirrels, the most common predators in the study area, were thought to be at least partly responsible for the low nest survival rate. While Falconer (2010) suggested that the decline of Eastern Wood-pewees in the Lower Great Lakes Region might be linked to increasing populations of Blue Jays, population increases of jays have generally been rather modest. It is also difficult to understand why wood-pewee nests would preferentially be targeted by jays. On balance, it would seem that this is a low threat in terms of scope and severity.

Degradation of Breeding Habitat from Over-browsing by White-tailed Deer

McCarty (1996) suggested that over-browsing by White-tailed Deer (*Odocoileus virginianus*) could be a potential threat to Eastern Wood-pewees. Over-browsing is known to dramatically change the structure of deciduous and mixed forests in eastern North America by decreasing plant and tree diversity and density, and by reducing the shrub/sapling layer (e.g., Collard *et al.* 2011; Tanentzap *et al.* 2011). Although removal of the shrub layer by deer may fulfill the wood-pewee's structural habitat needs in the short term, long-term decreases in understory composition and density could have negative effects (DeGraaf *et al.* 1991; deCalesta 1994), perhaps by reducing the density and diversity of insect prey (e.g., Baines *et al.* 1994; Allombert *et al.* 2005).

In Pennsylvania, Eastern Wood-pewees were reported to be locally absent from sites with deer densities >8 deer/km^2 due to change in habitat structure of the intermediate canopy (deCalesta 1994). However, in another local study in Virginia, there did not appear to be any relationship between deer density and pewee abundance (McShea and Rappole 2000). Although deer densities can be very high in some parts of the species' range in Canada, such as at Rondeau Provincial Park (55 deer km^2 in the 1980s; Tanentzap *et al.* 2011), the pewee still persists as one of the park's most common forest birds (Gartshore 1994). Similar situations occur elsewhere in Ontario, notably at Long Point and Point Pelee (McCracken *et al.* 1981; Lepage *et al.* 2009). Given the weakness of the evidence for an effect, over-abundance of deer should be regarded as posing a low level threat to the Eastern Wood-pewee.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

In Canada, the Eastern Wood-pewee and its nests and eggs are protected under the *Migratory Birds Convention Act*. It occurs in national parks and historic sites across eastern Canada, where it is protected by the *Canada National Parks Act*. In Québec, it is protected under the *Loi sur la conservation et la mise en valeur de la faune* (L.R.Q., c. C-61.1) (*Act respecting the conservation and development of wildlife*) (R.S.Q., c. C-61.1). By this law, it is illegal to disturb, destroy, or damage the eggs or nest of an animal. It is also prohibited to hunt, capture, or keep in captivity without a specific permit. This species is not listed under the *Loi sur les espèces menacées ou vulnérables* (L.R.Q., chapitre E-12.01) (*Act respecting threatened or vulnerable species*) (R.S.Q., c E-12.01) and it is not on the list of wildlife species which are likely to be designated vulnerable or threatened. In Ontario, the *Fish and Wildlife Conservation Act* (S.O. 1997, c.41, 7. [1]) offers similar protection, as does the New Brunswick *Fish & Wildlife Act* (S.N.B. 1980, c. F-14.1).

Non-Legal Status and Ranks

At the global level, the species is considered secure (G5, last reviewed in 1996; see Table 3) by NatureServe (2012). The species is considered 'Least concern' according to the IUCN Red List (NatureServe 2012).

In Canada, the Eastern Wood-pewee is considered 'secure' (N5; last reviewed in 2011; NatureServe 2012). It is considered 'apparently secure' (S4) in Saskatchewan, Manitoba, Ontario, and Prince Edward Island, 'vulnerable' to 'apparently secure' (S3/S4) in Québec, and 'secure' (S5) in New Brunswick (NatureServe 2012; Table 3). The General Status Ranking for the Eastern Wood-pewee considers the species secure in Canada and most provinces except Nova Scotia and Ontario where it is sensitive (CESCC 2011; Table 3).

In the United States, the species is considered 'secure' nationally (N5). At the state level, it is considered 'secure' (S5) or 'apparently secure' (S4) in most states, except South Dakota, where it is considered 'vulnerable' (S3; NatureServe 2012).

Habitat protection and ownership

In Canada, Eastern Wood-pewee habitat occurs on a mix of both public and private lands, but little information is available on their relative proportions. In New Brunswick, there is about 1 million ha of habitat suitable for pewees (much of it Crown land), which accounts for about 14% of the province's land base (Sabine pers. comm. 2012).

Crown forests in Canada receive various kinds and intensities of active management. For example, on Crown land in Ontario, the supply of all forest habitat types and development stages, including mature deciduous, mixed and coniferous stands, is regulated through the *Crown Forest Sustainability Act* (1994) and the Class Environmental Assessment for Forestry (2003). These Acts require forest management to emulate natural disturbances and natural landscape patterns to conserve biological diversity and likely therefore maintain habitat for the Eastern Wood-pewee in Crown forests (OMNR 2009). Likewise, in New Brunswick, the maintenance of habitat for wildlife species is a requirement of Crown forest management under the *Crown Lands and Forest Act, 2011*. Area targets and stand/landscape descriptions have been developed for six types of old forest habitats, including Old Tolerant Hardwood Habitat, which is favoured by Eastern Wood-pewees. Forest management plans include the spatial identification of area to meet habitat targets in appropriate stand and landscape configurations (New Brunswick Department of Natural Resources 2005).

Relatively small portions (likely less than 10%) of the deciduous and mixed forests in southeastern Canada are protected within national and provincial parks, migratory bird sanctuaries and national wildlife areas. According to Parks Canada's Biotics database, the Eastern Wood-pewee is present in 21 protected areas managed by Parks Canada (Parks Canada 2011). The species is also reported on 13 Department of

National Defence establishments, where it is believed to be a fairly common breeder (D. Nernberg unpubl. data 2011). It also occurs in a large number of provincially protected natural areas. For example, in New Brunswick, there are about 61 Protected Natural Areas totalling about 158,000 ha (2.1% of the provincial landbase) that are managed under the province's *Protected Natural Areas Act*. Industrial, commercial, agricultural uses and development are prohibited in these areas.

Table 3. Ranks assigned to the Eastern Wood-pewee in North America, based on NatureServe (2012) and General Status Ranks (CESCC 2011).

Region	Rank*	General Status**
Global	G5	---
United States	N5B	---
Canada	N5B	Secure
Saskatchewan	S4B	Secure
Manitoba	S4S5B	Secure
Ontario	S4B	Sensitive
Québec	S3S4B	Secure
New Brunswick	S5B	Secure
Nova Scotia	S4B	Sensitive
Prince Edward Island	S4B	Secure

* The NatureServe global rank was last reviewed in 1996; the Canadian national rank was reviewed in 2011. G = global status rank; N= national status rank; S = rank assigned to a province or state; S1 indicates that a species is critically imperiled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines, making it especially vulnerable to extirpation; S2 indicates that a species is imperiled because of rarity or other factors making it very vulnerable to extirpation, usually with 6 to 20 occurrences or few individuals remaining (i.e., 1000 to 3000); S3 indicates that a species is vulnerable at the subnational level because it is rare or uncommon, or found only in a restricted range, or because of other factors making it vulnerable to extirpation; S4 indicates a species is apparently secure; S5 indicates that a species is secure because it is common, widespread, and abundant in the state/province.

** Secure: Species that are not believed to belong in the categories *Extirpated*, *Extinct*, *At Risk*, *May Be At Risk*, *Sensitive*, *Accidental* or *Exotic*. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant. Sensitive: Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.

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